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(54) **POSTERIOR STABILIZED ORTHOPAEDIC PROSTHESIS**

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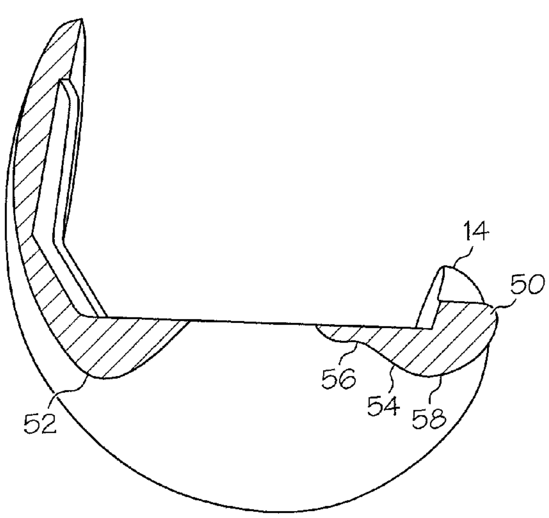
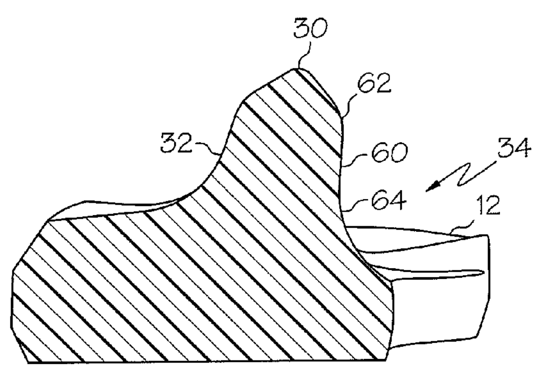
(57) **ABSTRACT**

A posterior stabilized knee orthopaedic prosthesis includes a tibial bearing and a femoral component configured to articulate with the tibial bearing. The tibial bearing includes a spine having a concave cam surface and a convex cam surface. The femoral component includes a posterior cam having a concave cam surface and a convex cam surface. During flexion, the concave cam surface of the posterior cam contacts the convex cam surface of the spine and the convex cam surface of the posterior cam contacts the concave cam surface of the spine.

12 Claims, 12 Drawing Sheets





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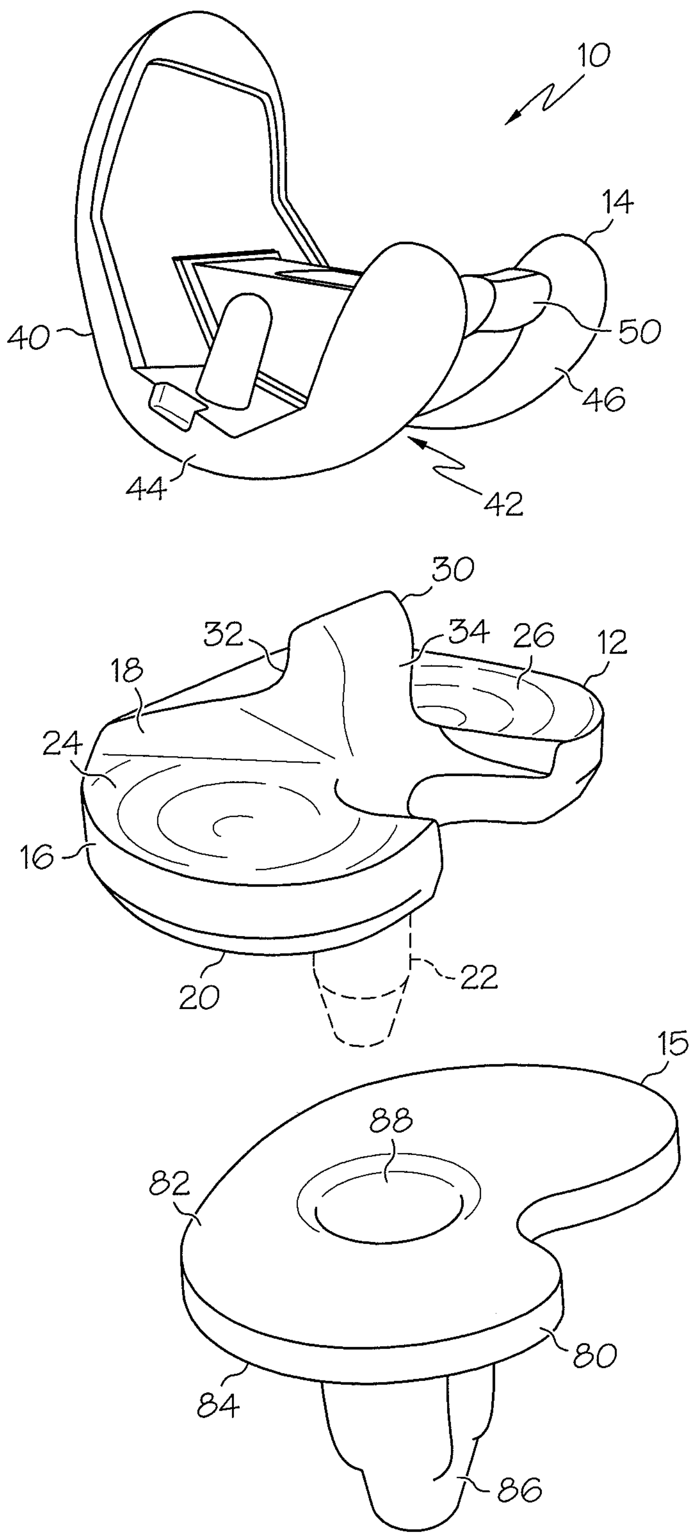


FIG. 1

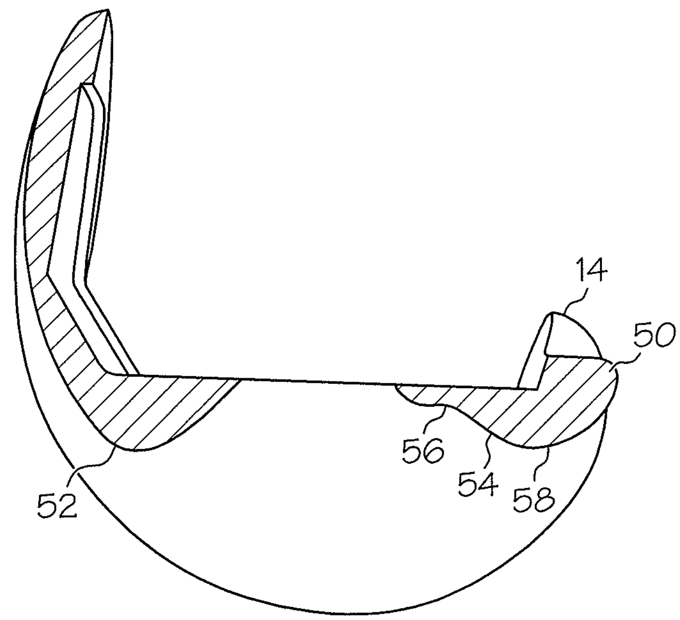
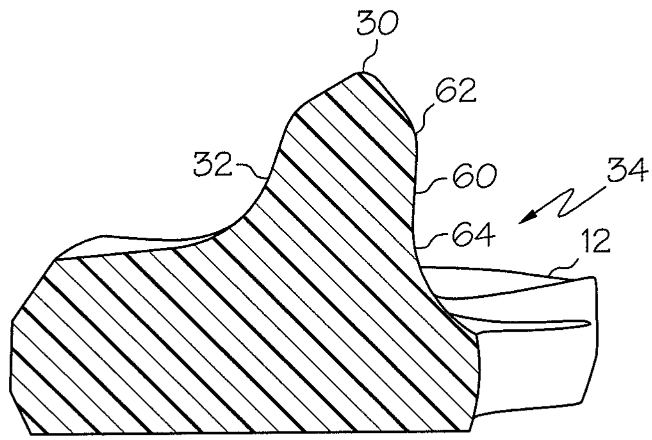


FIG. 2



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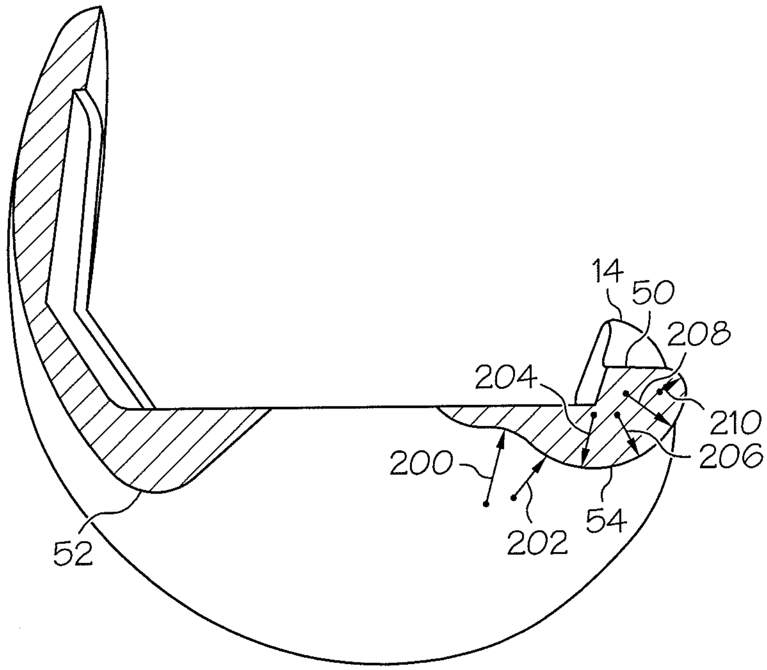

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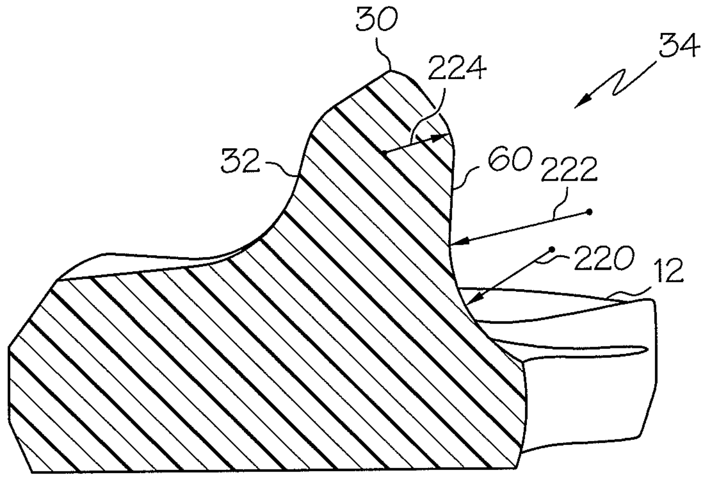

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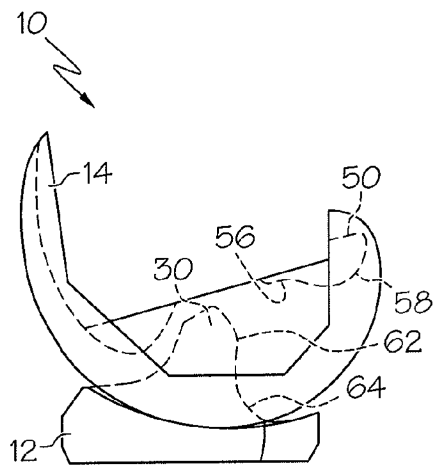

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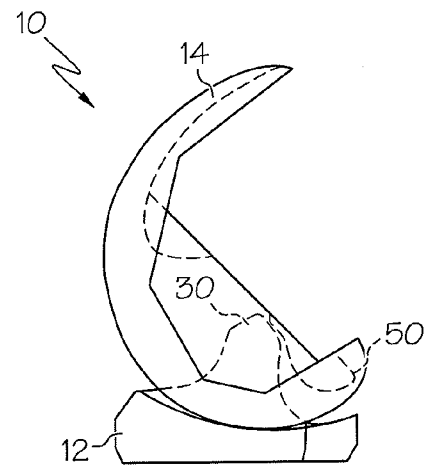
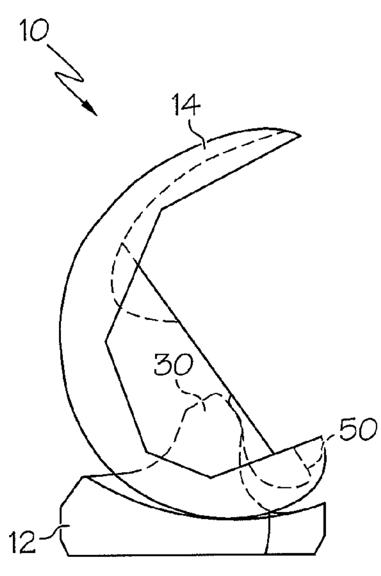


FIG. 7



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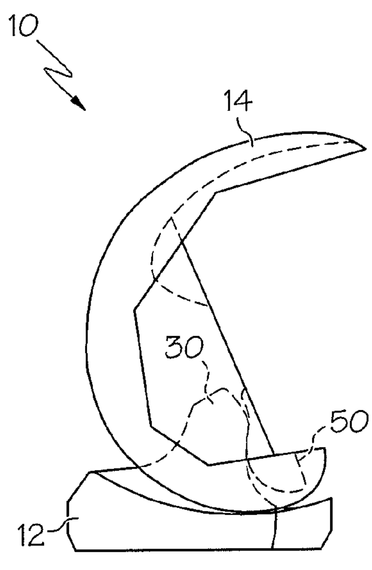

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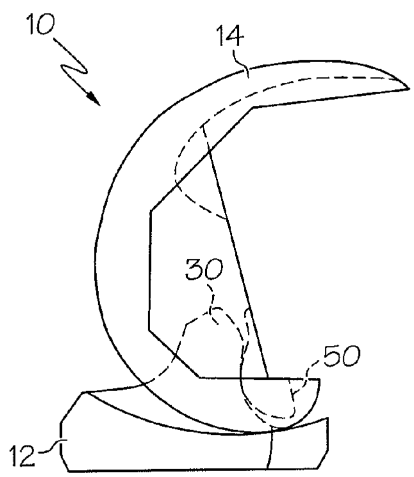

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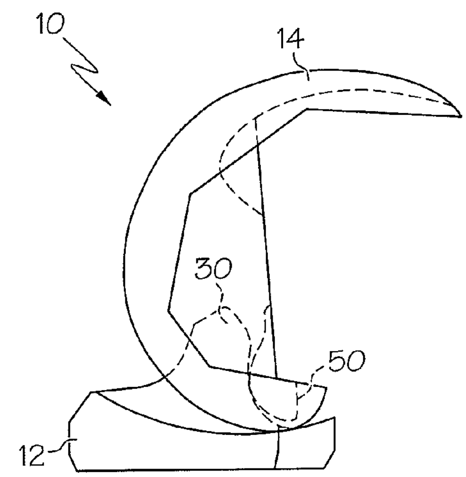
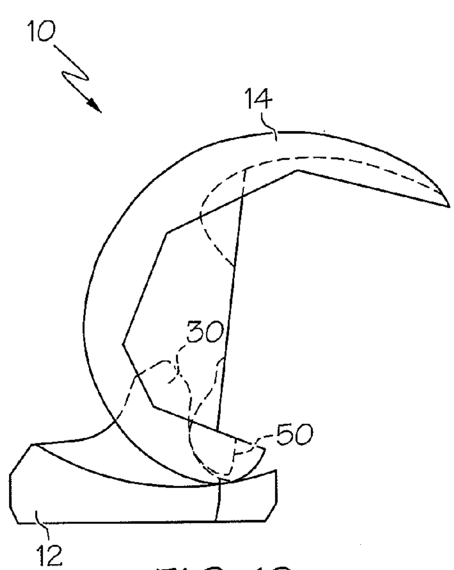


FIG. 11



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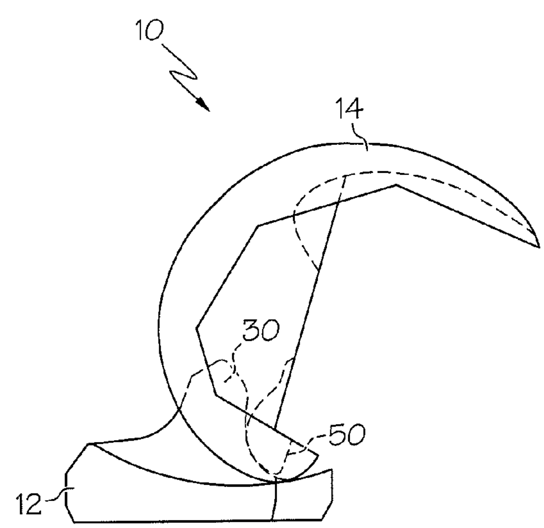


FIG. 13

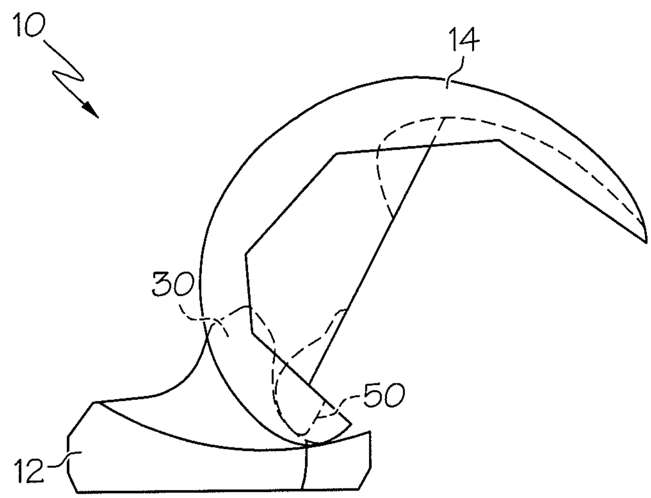


FIG. 14

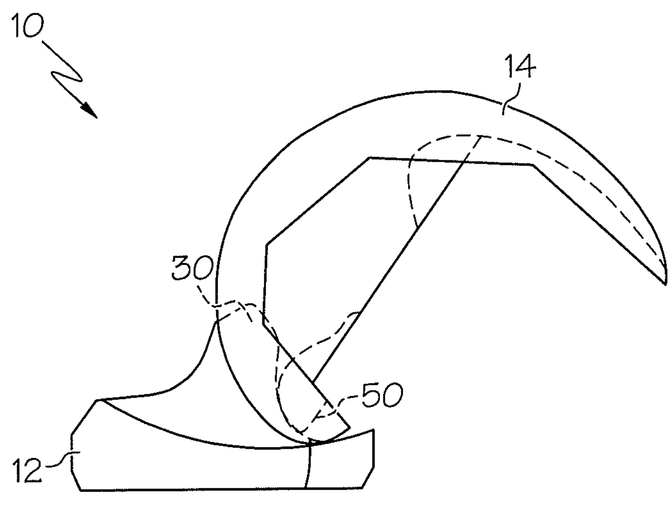


FIG. 15

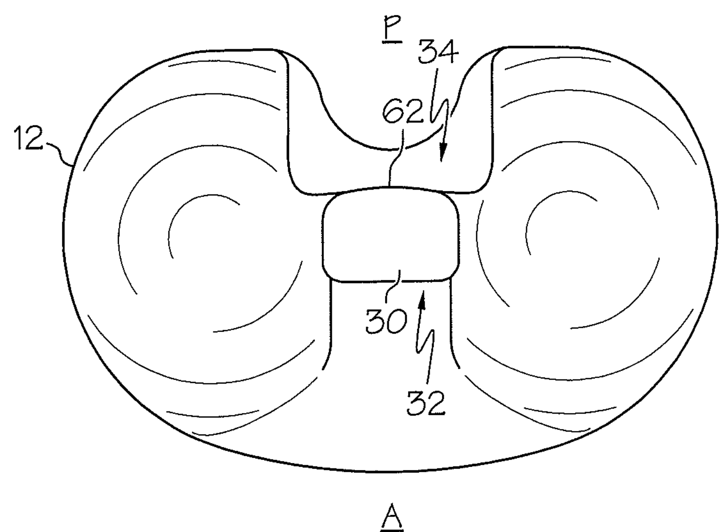


FIG. 16

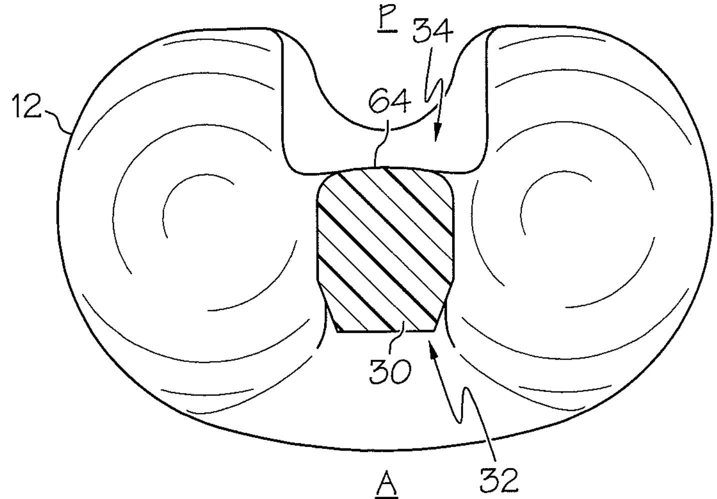


FIG. 17

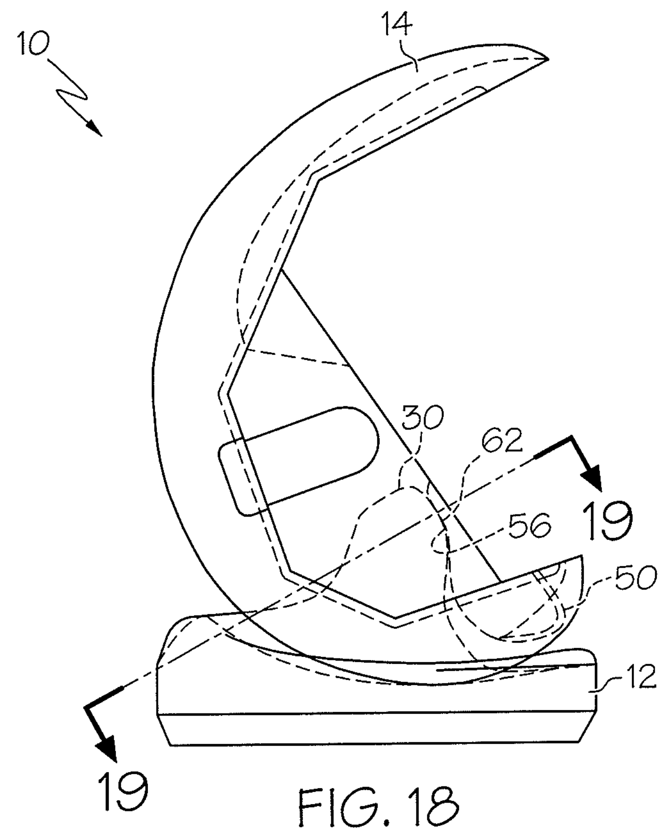
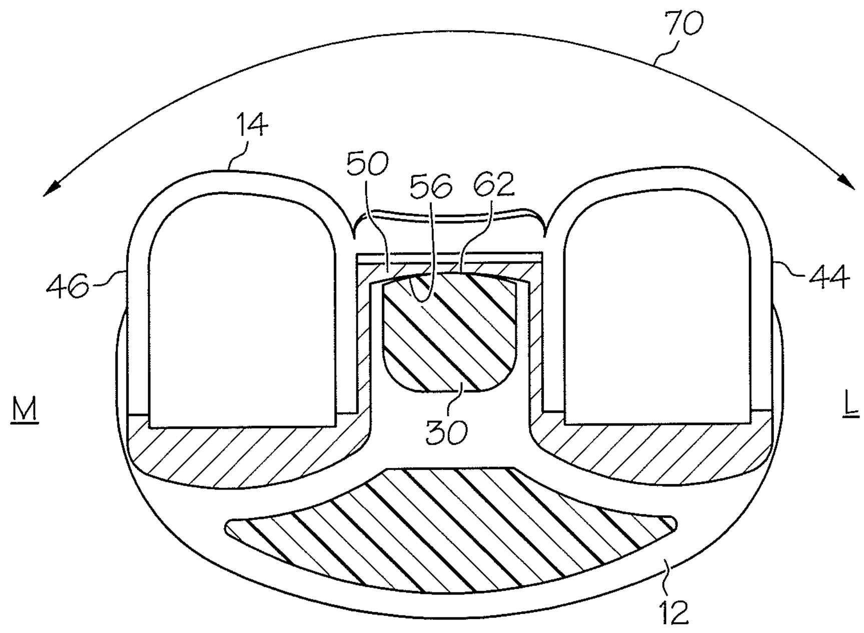


FIG. 18



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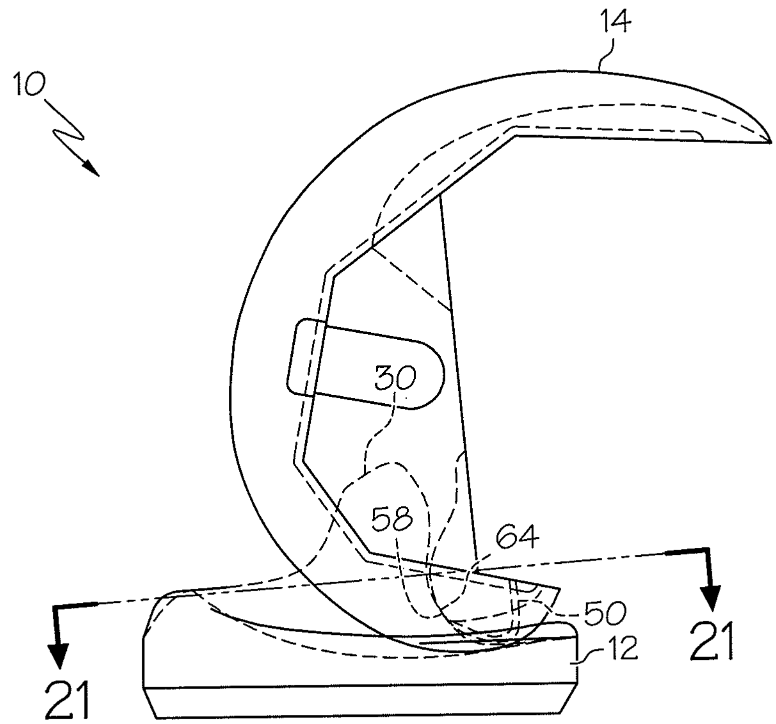

FIG. 20

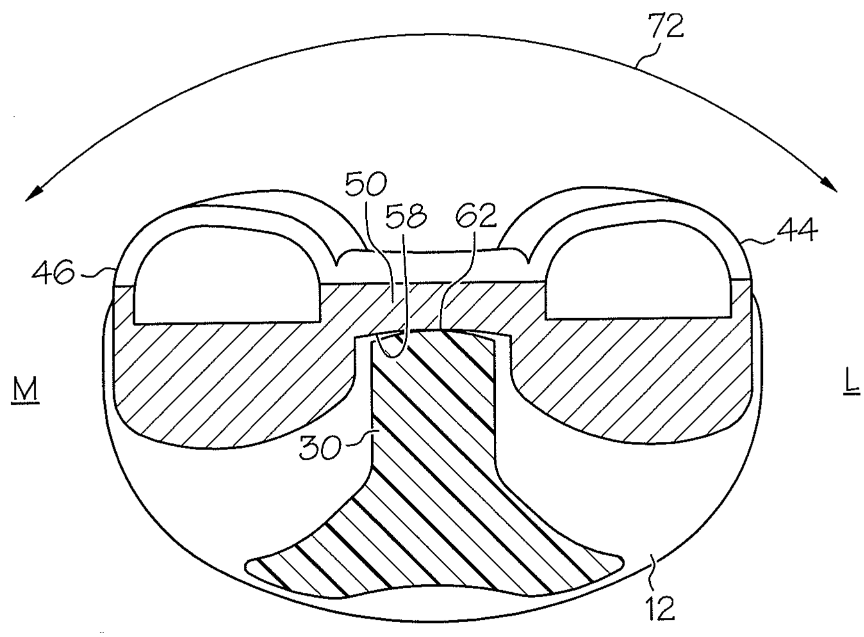

FIG. 21

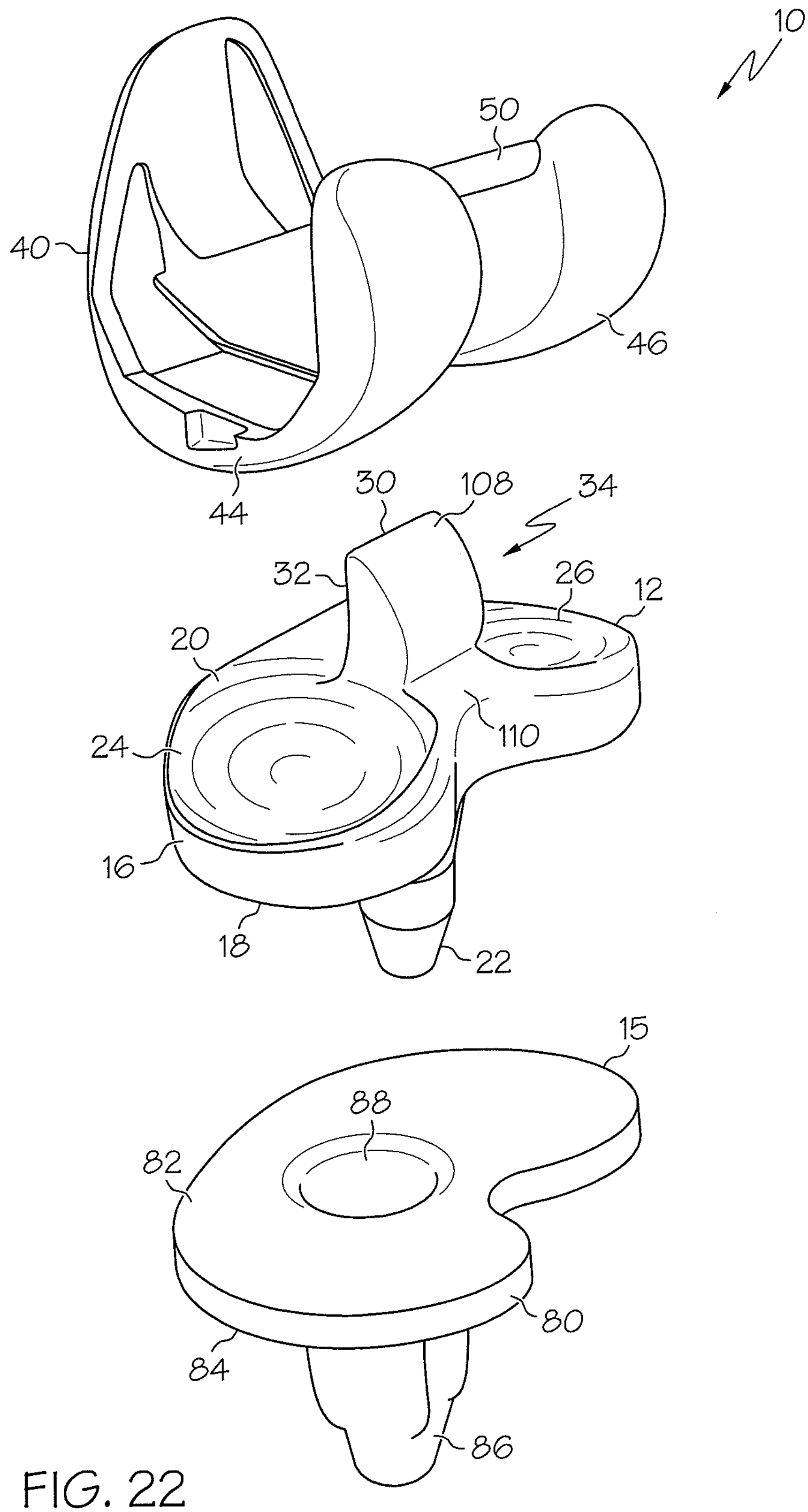

FIG. 22

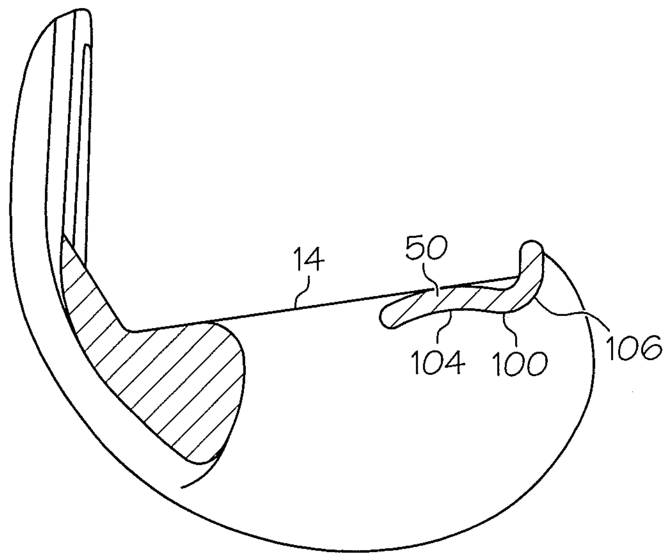

FIG. 23

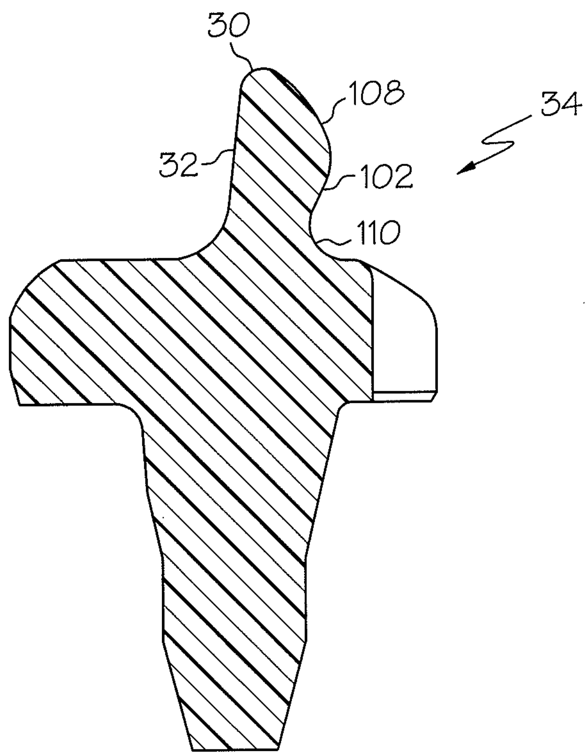

FIG. 24

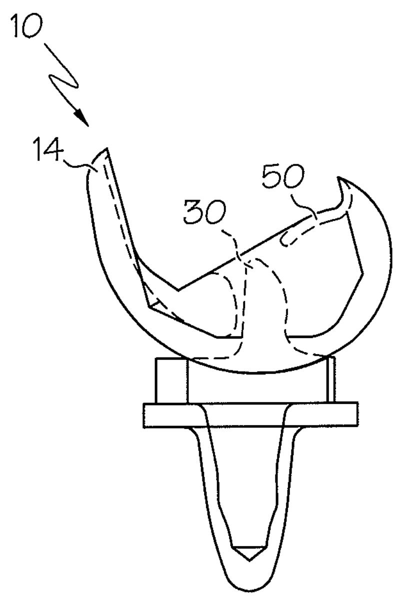

FIG. 25

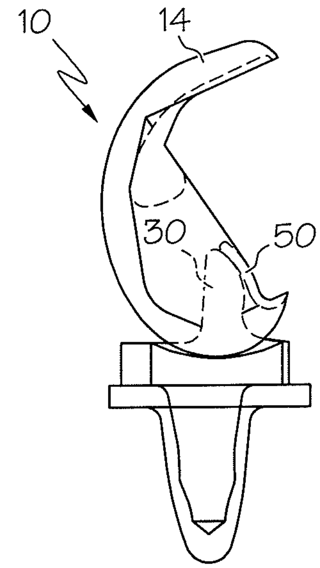

FIG. 26

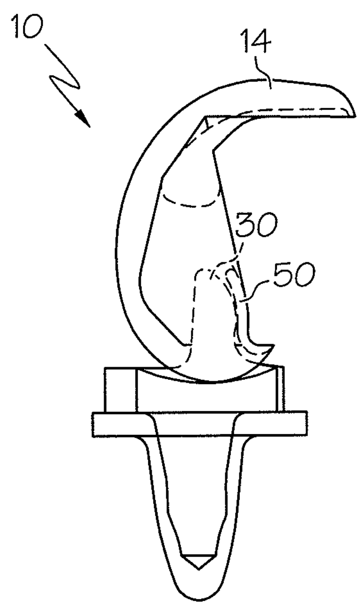

FIG. 27

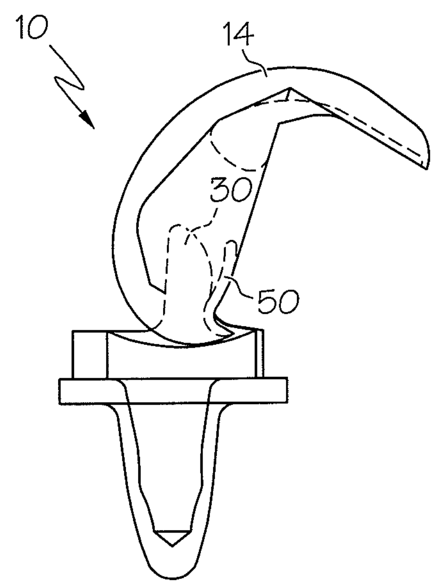

FIG. 28

POSTERIOR STABILIZED ORTHOPAEDIC PROSTHESIS

This application is a continuation of U.S. Utility patent application Ser. No. 13/527,758, which was filed on Jun. 20, 2012 and was a continuation of U.S. Utility patent application Ser. No. 12/165,582 entitled "Posterior Stabilized Orthopaedic Prosthesis," which was filed on Jun. 30, 2008 and issued as U.S. Pat. No. 8,206,451 on Jun. 26, 2012. The entirety of each of those applications is incorporated herein by reference.

CROSS-REFERENCE TO RELATED U.S. PATENT APPLICATION

Cross-reference is made to U.S. Utility patent application Ser. No. 12/165,579 entitled "Orthopaedic Femoral Component Having Controlled Condylar Curvature" by John L. Williams et al., which was filed on Jun. 30, 2008; to U.S. Utility patent application Ser. No. 12/165,574 entitled "Posterior Cruciate-Retaining Orthopaedic Knee Prosthesis Having Controlled Condylar Curvature" by Christel M. Wagner, which was filed on Jun. 30, 2008 and issued as U.S. Pat. No. 8,192,498 on Jun. 5, 2012; and to U.S. Utility patent application Ser. No. 12/165,575 entitled "Posterior Stabilized Orthopaedic Knee Prosthesis Having Controlled Condylar Curvature" by Joseph G. Wyss, which was filed on Jun. 30, 2008 and issued as U.S. Pat. No. 8,187,335 on, May 29, 2012; and to U.S. Utility patent application Ser. No. 12/488,107 entitled "Orthopaedic Knee Prosthesis Having Controlled Condylar Curvature" by Mark A. Heldreth, which was filed on Jun. 19, 2009 and issued as U.S. Pat. No. 8,236,061 on Aug. 7, 2012; the entirety of each of which is incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates generally to orthopaedic prostheses, and particularly to posterior stabilized orthopaedic prostheses for use in knee replacement surgery.

BACKGROUND

Joint arthroplasty is a well-known surgical procedure by which a diseased and/or damaged natural joint is replaced by a prosthetic joint. A typical knee prosthesis includes a tibial tray, a femoral component, and a polymer insert or bearing positioned between the tibial tray and the femoral component. A knee prosthesis is generally designed to duplicate the natural movement of the patient's joint. However, depending on the severity of the damage to the patient's joint, orthopaedic prostheses of varying mobility may be used. For example, in some patients, the posterior cruciate ligament may be damaged, deficient, or removed during the orthopaedic surgical procedure. In such cases, a posterior stabilized knee orthopaedic prosthesis, which typically restricts or limits the posterior movement of the tibia relative to the femur, may be used.

SUMMARY

According to one aspect, a posterior stabilized knee orthopaedic prosthesis includes a tibial bearing and a femoral component. The tibial bearing may be configured to be coupled to a tibial tray and may include a platform and a spine extending upwardly from the platform. The spine may have a posterior side including a superior and an inferior cam surface.

The superior cam surface may be embodied as a convex cam surface and the inferior cam surface may be embodied as a concave cam surface. The radius of curvature of the concave cam surface of the spine of the tibial bearing may be substantially equal to or different from the radius of curvature of the convex cam surface of the spine.

In some embodiments, the superior cam surface of the spine of the tibial bearing may be convexly curved in the sagittal plane. Additionally, the inferior cam surface of the spine may be concavely curved in the sagittal plane. Further, in some embodiments, the superior cam surface and the inferior cam surface of the spine may be convexly curved in the transverse plane. In such embodiments, the radius of curvature in the transverse plane of the inferior, concave cam surface of the spine may be substantially equal to or different from the radius of curvature in the transverse plane of the superior, convex cam surface of the spine.

The femoral component of the orthopaedic prosthesis may be configured to articulate with the tibial bearing. The femoral component may include a pair of spaced apart condyles defining an intracondylar notch therebetween and a posterior cam positioned in the intracondylar notch. The posterior cam may include a concave cam surface and a convex cam surface. The tibial bearing and the femoral component are configured such that the concave cam surface of the posterior cam may contact the convex cam surface of the spine during a first range of flexion and the convex cam surface of the posterior cam may contact the concave cam surface of the spine during a second range of flexion. The first range of flexion may be less than the second range of flexion in some embodiments. For example, in one particular embodiment, the first range of flexion is about 50 degrees of flexion to about 80 degrees of flexion and the second range of flexion is about 80 degrees of flexion to about 150 degrees of flexion.

In some embodiments, the spine of the tibial bearing and the posterior cam of the femoral component may each have a substantially "S"-shaped cross-sectional profile. Additionally, in some embodiments, the radius curvature of the convex cam surface of the spine may be greater than the radius of curvature of the concave cam surface of the spine. Further, in such embodiments, the radius of curvature of the concave cam surface of the posterior cam of the femoral component may be substantially greater than the radius of curvature of the convex cam surface of the posterior cam.

According to another aspect, a posterior stabilized knee orthopaedic prosthesis may include a tibial bearing configured to be coupled to a tibial tray and a femoral component configured to be coupled to a surgically-prepared surface of the distal end of a femur. The tibial bearing may include a platform and a spine extending upwardly from the platform. The spine may include a posterior superior cam surface and a posterior inferior cam surface. The posterior superior cam surface may be concave and the posterior inferior cam surface may be convex.

In some embodiments, the radius of curvature of the superior cam surface of the spine of the tibial bearing may be substantially equal to the radius of curvature of the inferior cam surface of the spine. The superior cam surface may be concavely curved in the sagittal plane. Similarly, the inferior cam surface may be convexly curved in the sagittal plane. Additionally, in some embodiments, the superior cam surface of the spine of the tibial bearing may be convexly curved in the sagittal plane and the inferior cam surface of the spine may be concavely curved in the sagittal plane. The posterior inferior cam surface and the posterior superior cam surface of the spine may also be convexly curved in the transverse plane. In such embodiments, the radius of curvature in the transverse plane of the inferior cam surface of the spine may be substantially equal to or different from the radius of curvature in the transverse plane of the convex cam surface of the spine.

The femoral component may include a posterior cam configured to articulate with the spine of the tibial bearing. The posterior cam may include a concave cam surface and a convex cam surface. In some embodiments, the spine of the tibial bearing and the posterior cam of the femoral component may each have a substantially "S"-shaped cross-sectional profile. Additionally, in some embodiments, the radius curvature of the posterior convex cam surface of the spine may be substantially greater than the radius of curvature of the posterior concave cam surface of the spine and the radius of curvature of the convex cam surface of the posterior cam of the femoral component is substantially greater than the radius of curvature of the concave cam surface of the posterior cam. The tibial bearing and the femoral component are configured such that the concave cam surface of the posterior cam articulates on the posterior convex cam surface of the spine during a first range of flexion and the convex cam surface of the posterior cam articulates on the posterior concave cam surface of the spine during a second range of flexion greater than the first range of flexion.

According to a further aspect, a posterior stabilized knee orthopaedic prosthesis may include a tibial bearing configured to be coupled to a tibial tray and a femoral component configured to be coupled to a surgically-prepared surface of the distal end of a femur. The tibial bearing may include a platform including a medial bearing surface and a lateral bearing surface. The tibial bearing may also include a spine extending upwardly from the platform between the medial bearing surface and the lateral bearing surface. The spine may include a concave cam surface and a convex cam surface.

The femoral component may include a lateral condyle configured to articulate with the lateral bearing surface of the tibial bearing, a medial condyle configured to articulate with the medial bearing surface, and a posterior cam positioned in an intracondylar notch defined between the lateral condyle and the medial condyle. The posterior cam may include a concave cam surface and a convex cam surface. The concave cam surface of the posterior cam may initially contact the convex cam surface of the spine at a first degree of flexion and the convex cam surface of the posterior cam may initially contact the concave cam surface of the spine at a second degree of flexion greater than the first degree of flexion.

BRIEF DESCRIPTION OF THE DRAWINGS

The detailed description particularly refers to the following figures, in which:

FIG. **1** is an exploded perspective view of one embodiment of an orthopaedic prosthesis;

FIG. **2** is a cross-sectional view of one embodiment of a femoral component of the orthopaedic prosthesis of FIG. **1**;

FIG. **3** is a cross-sectional view of one embodiment of a tibial bearing of the orthopaedic prosthesis of FIG. **1**;

FIG. **4** is another cross-sectional view of the femoral component of FIG. **2**;

FIG. **5** is another cross-sectional view of the tibial bearing of FIG. **3**;

FIGS. **6-15** are side elevational views of the orthopaedic prosthesis of FIG. **1** at various degrees of flexion;

FIG. **16** is a top plan view of another embodiment of the tibial bearing of the orthopaedic prosthesis of FIG. **1**;

FIG. **17** is a cross-sectional plan view of the tibial bearing of FIG. **16** having a portion of the spine removed;

FIG. **18** is a side elevational view of one embodiment of an orthopaedic prosthesis including the tibial bearing of FIG. **16** positioned in an early degree of flexion;

FIG. **19** is a cross-sectional view of the orthopaedic prosthesis of FIG. **18** taken generally along the section line **19-19**;

FIG. **20** is a side elevational view of the orthopaedic prosthesis of FIG. **18** positioned in a late degree of flexion;

FIG. **21** is a cross-sectional view of the orthopaedic prosthesis of FIG. **20** taken generally along the section line **21-21**;

FIG. **22** is an exploded perspective view of another embodiment of an orthopaedic prosthesis;

FIG. **23** is a cross-sectional view of one embodiment of a femoral component of the orthopaedic prosthesis of FIG. **22**;

FIG. **24** is a cross-sectional view of one embodiment of a tibial bearing of the orthopaedic prosthesis of FIG. **22**; and

FIGS. **25-28** are side elevational views of the orthopaedic prosthesis of FIG. **22** at various degrees of flexion.

DETAILED DESCRIPTION OF THE DRAWINGS

While the concepts of the present disclosure are susceptible to various modifications and alternative forms, specific exemplary embodiments thereof have been shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that there is no intent to limit the concepts of the present disclosure to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

Terms representing anatomical references, such as anterior, posterior, medial, lateral, superior, inferior, etcetera, may be used throughout this disclosure in reference to both the orthopaedic implants described herein and a patient's natural anatomy. Such terms have well-understood meanings in both the study of anatomy and the field of orthopaedics. Use of such anatomical reference terms in the specification and claims is intended to be consistent with their well-understood meanings unless noted otherwise.

Referring now to FIG. **1**, in one embodiment, a posterior stabilized knee orthopaedic prosthesis **10** includes a tibial insert or bearing **12**, a femoral component **14**, and a tibial tray **15**. The femoral component **14** is configured to articulate with the tibial bearing **12** during use. The tibial bearing **12** is illustratively formed from a polymer material such as a ultra-high molecular weight polyethylene (UHMWPE), but may be formed from other materials, such as a ceramic material, a metallic material, a bio-engineered material, or the like, in other embodiments. The femoral component **14** and the tibial tray **15** are illustratively formed from a metallic material such as cobalt-chromium or titanium, but may be formed from other materials, such as a ceramic material, a polymer material, a bio-engineered material, or the like, in other embodiments.

As discussed in more detail below, the femoral component **14** is configured to articulate with the tibial bearing **12**, which is configured to be coupled with the tibial tray **15**. The illustrative tibial bearing **12** is embodied as a rotating or mobile tibial bearing and is configured to rotate relative to the tibial tray **15** during use. However, in other embodiments, the tibial bearing **12** may be embodied as a fixed tibial bearing, which may be limited or restricted from rotating relative the tibial tray **15**.

The tibial tray **15** is configured to be secured to a surgically-prepared proximal end of a patient's tibia (not shown). The tibial tray **15** may be secured to the patient's tibia via use of bone adhesive or other attachment means. The tibial tray **15** includes a platform **80** having an top surface **82** and a bottom surface **84**. Illustratively, the top surface **82** is generally planar and, in some embodiments, may be highly polished. The tibial tray **15** also includes a stem **86** extending downwardly from the bottom surface **84** of the platform **80**. A cavity or bore **88** is defined in the top surface **82** of the platform **80** and extends downwardly into the stem **86**. The bore **88** is formed to receive a complimentary stem of the tibial bearing **12** as discussed in more detail below.

As discussed above, the tibial bearing **12** is configured to be coupled with the tibial tray **15**. The tibial bearing **12** includes a platform **16** having an upper bearing surface **18** and a bottom surface **20**. In the illustrative embodiment wherein the tibial bearing **12** is embodied as a rotating or mobile tibial bearing, the bearing **12** includes a stem **22** extending downwardly from the bottom surface **20** of the platform **16**. When the tibial bearing **12** is coupled to the tibial tray **15**, the stem **22** is received in the bore **88** of the tibial tray **15**. In use, the tibial bearing **12** is configured to rotate about an axis defined by the stem **22** relative to the tibial tray **15**. In embodiments wherein the tibial bearing **12** is embodied as a fixed tibial bearing, the bearing **12** may or may not include the stem **22** and/or may include other devices or features to secure the tibial bearing **12** to the tibial tray **15** in a non-rotating configuration.

The upper bearing surface **18** of the tibial bearing **12** includes a medial bearing surface **24**, a lateral bearing surface **26**, and a spine **30** extending upwardly from the platform **16**. The medial and lateral bearing surfaces **24**, **26** are configured to receive or otherwise contact corresponding medial and lateral condyles **44**, **46** of the femoral component **14** as discussed in more detail below. As such, the bearing surfaces **24**, **26** may have concave contours in some embodiments. The spine **30** is positioned between the bearing surfaces **24**, **26** and includes an anterior side **32** and a posterior side **34**.

The femoral component **14** is configured to be coupled to a surgically-prepared surface of the distal end of a patient's femur (not shown). The femoral component **14** may be secured to the patient's femur via use of bone adhesive or other attachment means. The femoral component **14** includes an articulating surface **40** having a pair of spaced apart medial and lateral condyles **44**, **46**. In use, the condyles **44**, **46** replace the natural condyles of the patient's femur and are configured to articulate on the corresponding bearing surfaces **24**, **26** of the platform **16** of the tibial bearing **12**.

The condyles **44**, **46** are spaced apart to define an intracondyle notch or recess **42** therebetween. A posterior cam **50** and an anterior cam **52** (see FIG. **2**) are positioned in the intracondyle notch **42**. The posterior cam **50** is located toward the posterior side of the femoral component **14** and is configured to engage or otherwise contact the spine **30** of the tibial bearing **12** during flexion as illustrated in and described in more detail below in regard to FIGS. **4-13**.

Referring now to FIGS. **2-5**, each of the posterior cam **50** of the femoral component **14** and the spine **30** of the tibial bearing **12** have a substantially "S"-shaped cross-sectional profile in the sagittal plane. In particular, as shown in FIG. **2**, the posterior cam **50** of the femoral component **14** includes a cam surface **54** configured to contact a cam surface **60** of the spine **30** during use. To do so, the cam surface **54** of the posterior cam **50** includes a concave cam surface **56** and a convex cam surface **58**. In the illustrative embodiment, the convex cam surface **58** is positioned posteriorly to the concave cam surface **56**. The cam surfaces **56**, **58** may have similar or different radius of curvatures. For example, in some embodiments, the convex cam surface **58** may have a radius of curvature substantially larger than the radius of curvature of the concave cam surface **56**. However, in other embodiments, the convex cam surface **58** may have a radius of curvature that is substantially equal to or less than the radius of curvature of the concave cam surface **56**.

In some embodiments, the curvature of the cam surfaces **56**, **58** may be defined by a single radius of curvature. The particular radius of curvature of the cam surfaces **56**, **58** (i.e., the "size" of the cam surfaces) may be dependent upon a number of criteria such as the size of the implant, the shape or geometry of the articulating surface of the spine **30** of the tibial implant **12**, and/or the like. In other embodiments, however, the concave cam surface **56** and the convex cam surface **58** of the femoral component **14** may be formed from multiple radii of curvature. For example, in the embodiment illustrated in FIG. **4**, the concave cam surface **56** is defined by a radius of curvature **200** and a radius of curvature **202**, each of which is tangent to the other. In one particular embodiment, the radius of curvature **200** is about 10.42 millimeters and the radius of curvature **202** is about 8.13 millimeters. Additionally, the convex cam surface **58** is defined by a plurality of radii of curvature **204**, **206**, **208**, and **210**. Each of the radii of curvature **204**, **206**, **208**, **210** is tangent with the each adjacent radius of curvature. In one particular embodiment, the radius of curvature **204** is about 7.14 millimeters, the radius of curvature **206** is about 7.01 millimeters, the radius of curvature **208** is about 7.30 millimeters, and the radius of curvature **210** is about 2.30 millimeters. In other embodiments, a larger or lesser number of radii of curvature may be used define the cam surfaces **56**, **58**. Additionally, the radii of curvature **200**, **202**, **204**, **206**, **208**, **210** may have other values in other embodiments.

Referring now to FIG. **3**, the cam surface **60** of the tibial bearing **12** is defined on the posterior side **34** of the spine **30**. Similar to the cam surface **54** of the posterior cam **50** of the femoral component **14**, the cam surface **60** of the spine **30** includes a convex cam surface **62** and a concave cam surface **64**. In the illustrative embodiment, the convex cam surface **62** is positioned superiorly relative to the concave cam surface **64**. Similar to the cam surfaces **56**, **58** of the posterior cam **50**, the cam surfaces **62**, **64** of the spine **30** may have similar or different radius of curvatures. For example, in some embodiments, the concave cam surface **64** has a radius of curvature substantially larger than the radius of curvature of the convex cam surface **62**. However, in other embodiments, the concave cam surface **64** may have a radius of curvature that is substantially equal to or less than the radius of curvature of the convex cam surface **62**.

In some embodiments, the curvature of the cam surfaces **62**, **64** may be defined by a single radius of curvature. The particular radius of curvature of the cam surfaces **62**, **64** (i.e., the "size" of the cam surfaces) may be dependent upon a number of criteria such as the size of the implant, the shape or geometry of the articulating surface of the posterior cam **50** of the femoral component **14**, and/or the like. In other embodiments, however, the convex cam surface **62** and the concave cam surface **64** of the tibial bearing **12** may be formed from multiple radii of curvature. For example, in the embodiment illustrated in FIG. **5**, the concave cam surface **64** is defined by a radius of curvature **220** and a radius of curvature **222**, each of which is tangent to the other. In one particular embodiment, the radius of curvature **220** is about 9.00 millimeters and the radius of curvature **222** is about 13.00 millimeters. The convex cam surface **62** is defined by a radius of curvature **224**. In one particular embodiment, the radius of curvature **224** is about 8.00 millimeters. Of course, in other embodiments, a larger or lesser number of radii of curvature may be used define the cam surfaces **62**,**64**. Additionally, the radii of curvature **220**, **222**, **224** may have other values in other embodiments.

Referring now to FIGS. **6**-**15**, the femoral component **14** and the tibial bearing **12** are configured such that the posterior cam **50** of the femoral component **14** contacts the spine **30** of the tibial bearing **12** during flexion. In particular, during early flexion, the concave cam surface **56** of the posterior cam **50** contacts the convex cam surface **62** of the spine **30**. As flexion of the orthopaedic prosthesis **10** is increased, the contact between the posterior cam **50** and the spine **30** transitions from contact between the concave cam surface **56** of the posterior cam **50** and the convex cam surface **62** of the spine **30** to contact between the convex cam surface **58** of the posterior cam **50** and the concave surface **64** of the spine **30** during late flexion.

As shown in FIG. **6**, when the orthopaedic prosthesis **10** is in extension or is otherwise not in flexion (e.g., a flexion of about 0 degrees), the posterior cam **50** is not in contact with the spine **30**. However, during early flexion as illustrated in FIGS. **7** and **8**, the posterior cam **50** of the femoral component **14** contacts the spine **30** of the tibial bearing **12**. For example, in one embodiment as illustrated in FIG. **7**, as the orthopaedic prosthesis **10** is moved in flexion, the concave cam surface **56** of the posterior cam **50** initially contacts the convex cam surface **62** of the spine at a predetermined degree of flexion. In the illustrative embodiment, the femoral component **14** and the tibial bearing **12** are configured such that the cam surfaces **56**, **62** initially contact each other at about 60 degrees of flexion. However, in other embodiments, the degree of flexion at which initial contact between the posterior cam **50** and the spine **30** is established may be determined based on particular criteria such as the size of the orthopaedic prosthesis **10**, the shape or geometry of the articulating surface of the femoral component **14** and/or the tibial bearing **12**, and/or the like.

During early flexion of the orthopaedic prosthesis **10**, contact between the concave cam surface **56** and the convex cam surface **62** is maintained. For example, in one embodiment as shown in FIG. **8**, the convex cam surface **62** of the spine **30** may be fully "seeded" in the concave cam surface **56** of the posterior cam **50** at about 60 degrees of flexion. After early flexion, the contact between the posterior cam **50** and the spine **30** transitions from the cam surfaces **56**, **62** to the cam surfaces **58**, **64**. For example, in one embodiment as illustrated in FIG. **9**, the contact between the posterior cam **50** and the spine **30** begins transitioning to the cam surfaces **58**, **64** at about 80 degrees. At this degree of flexion, initial contact between the convex cam surface **58** of the posterior cam **50** and the concave cam surface **64** of the spine **30** may be established.

During late flexion of the orthopaedic prosthesis **10**, the convex cam surface **58** maintains contact with the concave cam surface **64**. For example, FIGS. **10**-**15** illustrate one embodiment at various degrees of late flexion. In particular, the orthopaedic prosthesis **10** is illustrated at about 100 degrees of flexion in FIG. **10**, at about 110 degrees of flexion in FIG. **11**, at about 120 degrees of flexion in FIG. **12**, at about 130 degrees of flexion in FIG. **13**, at about 140 degrees of flexion in FIG. **14**, and at about 150 degrees of flexion in FIG. **15**.

It should be appreciated that contact between the posterior cam **50** and the spine **30** is maintained throughout the range of early and late flexion. The particular range of early flexion (i.e., the range at which the concave cam surface **56** of the posterior cam **50** contacts the convex cam surface **62** of the spine **30**) and late flexion (i.e., the range at which the convex cam surface **58** of the posterior cam **50** contacts the concave cam surface **64** of the spine **30**) of the orthopaedic prosthesis **10** may be dependent upon one or more criteria such as the size of the orthopaedic prosthesis **10**, the shape or geometry of the articulating cam surfaces of the tibial bearing **12** and the femoral component **14**, or the like. In the illustrative embodiment, the orthopaedic prosthesis **10** is configured to have an early flexion range of about 50 degrees to about 80 degrees and a late flexion range of about 80 degrees to about 150 degrees, but other ranges of flexion may be used in other embodiments. The range of early and late flexion of the orthopaedic prosthesis **10** is determined, in part, based on the radius of curvature of the cam surface **56**, **58**, **62**, **64**. As such, the range of early and late flexion of the orthopaedic prostheses **10** may be configured by adjusting the radius of curvature of the cam surfaces **56**, **58**, **62**, **64**.

It should also be appreciated that because the cam surface **54** of the posterior cam **50** includes the concave cam surface **56** and the convex cam surface **58** and the cam surface **34** of the spine **30** includes the convex cam surface **62** and the concave cam surface **64**, the contact surface area between the posterior cam **50** and the spine **30** is increased through the flexion range relative to orthopaedic prostheses wherein the posterior cam and/or the spine include planar cam surfaces or cam surfaces having only a concave or convex surface. For example, the contact area between the posterior cam **50** and the spine **30** is increased in early flexion due to the interface between the concave cam surface **56** of the posterior cam **50** and the convex cam surface **62** of the spine **30**. Additionally, in late flexion, the contact area between the posterior cam **50** and the spine **30** is increased in later degrees of flexion due to the interface between the convex cam surface **58** of the posterior cam **50** and the concave cam surface **64** of the spine **30**. Because the contact between the posterior cam **50** and the spine **30** is spread across a greater contact area, the anterior wear of the spine **30** may also be decreased.

Referring now to FIGS. **16** and **17**, in some embodiments, the posterior side **34** of the spine **30** may also be curved in the transverse plane. That is, each of the superior, convex cam surface **62** and the inferior, concave cam surface **64** may be convex in the transverse plane direction. For example, as illustrated in FIG. **16**, the convex cam surface **62** of the spine **30** may be convexly curved in the transverse plane. Additionally, as illustrated in FIG. **17**, the concave cam surface **64** of the spine **30** may be convexly curved in the transverse plane. The radius of curvature in the transverse plane of the convex cam surface **62** and the concave cam surface **64** may be substantially equal or different. For example, in some embodiments, the radius of curvature in the transverse plane of the concave cam surface **64** may be greater than the radius of curvature in the transverse plane of the convex cam surface **62**. Alternatively, in other embodiments, the radius of curvature in the transverse plane of the convex cam surface **62** may be greater than the radius of curvature in the transverse plane of the concave cam surface **64**.

In embodiments wherein the cam surfaces **62**, **64** of the spine **30** are curved in the transverse plane, the posterior cam **50** of the femoral component **14** articulates on the cam surfaces **62**, **64** in the transverse plane such that the femoral component **14** rotates an amount about the spine **30**. For example, as illustrated in FIGS. **18** and **19**, when the concave cam surface **56** of the posterior cam **50** is in contact with the convex cam surface **62** of the spine **30** during early flexion, the femoral component **14** may rotate about the spine **30** in a generally medial-lateral direction in the transverse plane as indicated by arrow **70**. In such embodiments, the concave cam surface **56** of the posterior cam **50** may be substantially planar in the medial-lateral direction in some embodiments.

Alternatively, similar to the convex cam surface **62** of the spine **30**, the concave cam surface **56** of the posterior cam **50** of the femoral component **14** may also be curved in the medial-lateral direction. For example, as illustrated in FIG. **19**, the concave cam surface **56** may be concavely curved in the medial-lateral direction. In some embodiments, the radius of curvature in the medial-lateral direction of the concave cam surface **56** may be substantially equal to the radius of curvature in the transverse plane of the convex cam surface **62** of the spine **30**. Alternatively, the radius of curvature in the medial-lateral direction of the concave cam surface **56** may be greater or less than the radius of curvature in the transverse plane of the convex cam surface **62**. The amount of rotation between the femoral component **14** and the tibial bearing **12** during early flexion may be adjusted based on the radius of curvatures in the transverse plane of the cam surfaces **56**, **62**. For example, an increased amount of rotation during early flexion of the orthopaedic prosthesis may be obtained by decreasing the radius of curvature in the transverse plane of the convex cam surface **62**.

Referring now to FIGS. **20** an **21**, when the convex cam surface **58** of the posterior cam **50** is in contact with the concave cam surface **64** of the spine **30** during late flexion, the femoral component **14** may rotate about the spine **30** in a generally medially-laterally direction in the transverse plane as indicated by arrow **72** in some embodiments. In such embodiments, the convex cam surface **58** of the posterior cam **50** may be substantially planar in the medial-lateral direction. Alternatively, similar to the concave cam surface **64** of the spine **30**, the convex cam surface **58** of the posterior cam **50** of the femoral component **14** may be curved in the medial-lateral direction. For example, as illustrated in FIG. **21**, the convex cam surface **58** may be concavely curved in the medial-lateral direction. In some embodiments, the radius of curvature in the medial-lateral direction of the convex cam surface **58** may be substantially equal to the radius of curvature in the medial-lateral direction of the concave cam surface **64** of the spine **30**. Alternatively, the radius of curvature in the medial-lateral direction of the convex cam surface **58** may be greater or slightly less than the radius of curvature in the medial-lateral direction of the concave cam surface **64**. As discussed above in regard to early flexion, the amount of rotation between the femoral component **14** and the tibial bearing **12** during late flexion may be adjusted based on the radius of curvatures in the medial-lateral direction of the cam surfaces **58**, **64**.

As discussed above, the range of late flexion of the illustrative orthopaedic prosthesis **10** is greater than the range of early flexion. However, in other embodiments, the orthopaedic prosthesis **10** may have a range of early flexion that is greater than the range of late flexion. That is, because the range of early and late flexion of the orthopaedic prosthesis is determined, in part, based on the radius of curvature of the cam surface **56**, **58**, **62**, **64**, the range of early and late flexion may be adjusted by changing the radius of curvature of the cam surfaces **56**, **58**, **62**, **64** (i.e., the "size" of the cam surfaces). For example, as illustrated in FIGS. **22-28**, in another embodiment, the orthopaedic prosthesis **10** may include an early flexion range (i.e., the range at which the concave cam surface of the posterior cam **50** contacts the convex cam surface of the spine **30**) that is greater than the late flexion (i.e., the range at which the convex cam surface of the posterior cam **50** contacts the concave cam surface of the spine **30**).

In such embodiments, as illustrated in FIGS. **22-24**, the posterior cam **50** of the femoral component **14** includes a cam surface **100** configured to contact a cam surface **102** of the spine **30** during use. To do so, the cam surface **100** of the posterior cam **50** includes a concave cam surface **104** and a convex cam surface **106**. In the illustrative embodiment, the convex cam surface **106** is positioned posteriorly to the concave cam surface **104**. The concave cam surface **104** has a radius of curvature substantially larger than the radius of curvature of the convex cam surface **106**. As discussed above in regard to the cam surfaces **56**, **58**, the particular radius of curvature of the cam surfaces **104**, **106** (i.e., the "size" of the cam surfaces) may be dependent upon a number of criteria such as the size of the implant, the shape or geometry of the articulating surface of the femoral component **14** and/or the tibial bearing **12**, and/or the like. In one particular embodiment, the concave cam surface **104** has a radius of curvature of about 12.7 millimeters and the convex cam surface **106** has a radius curvature of about 6.4 millimeters

Similar to the cam surface **100** of the posterior cam **50** of the femoral component **14**, the cam surface **102** of the spine **30** includes a convex cam surface **108** and a concave cam surface **110**. In the illustrative embodiment, the convex cam surface **108** is positioned superiorly relative to the concave cam surface **110**. The convex cam surface **108** has a radius of curvature substantially larger than the radius of curvature of the concave cam surface **110**. Again, the particular radius of curvature of the cam surfaces **108**, **110** (i.e., the "size" of the cam surfaces) may be dependent upon a number of criteria such as the size of the implant, the patient's anatomy, and/or the like. In one particular embodiment, the convex cam surface **108** has a radius of curvature of about 10.3 millimeters and the concave cam surface **110** has a radius curvature of about 1.00 millimeters.

Because radius of curvature of the cam surfaces **104**, **108** are greater than the radius of curvature of the cam surfaces **106**, **110**, the range of early flexion of the embodiment of the orthopaedic prosthesis **10** illustrated in FIGS. **22-28** is greater than the range of late flexion. For example, as shown in FIG. **25**, when the orthopaedic prosthesis **10** is in extension or is otherwise not in flexion (e.g., a flexion of about 0 degrees), the posterior cam **50** is not in contact with the spine **30**. However, during early flexion as illustrated in FIG. **26**, the posterior cam **50** of the femoral component **14** contacts the spine **30** of the tibial bearing **12**. That is, during early flexion, the concave cam surface **104** of the posterior cam **50** contacts the convex cam surface **108** of the spine **30**. Because the radius of curvature of the cam surfaces **104**, **108** are increased, the cams surfaces **104**, **108** maintain contact with each other through a larger range of flexion. As such, the range of early flexion of the orthopaedic prosthesis is increased relative to embodiments wherein the radius of curvature of the cam surfaces **104**, **108** is decreased. After early flexion, the contact between the posterior cam **50** and the spine **30** transitions from the cam surfaces **104**, **108** to the cam surfaces **106**, **110**. For example, in one embodiment as illustrated in FIG. **27**, the contact between the posterior cam **50** and the spine **30** beings transitioning to the cam surfaces **106**, **110**. At this degree of flexion, initial contact between the convex cam surface **106** of the posterior cam **50** and the concave cam surface **110** of the spine **30** may be established. Subsequently, during late flexion of the orthopaedic prosthesis **10**, the convex cam surface **106** maintains contact with the concave cam surface **110** as illustrated in FIG. **28**.

Again, it should be appreciated that contact between posterior cam **50** and the spine **30** is maintained throughout the range of early and late flexion. The particular range of early flexion (i.e., the range at which the concave cam surface **104** of the posterior cam **50** contacts the convex cam surface **108** of the spine **30**) and late flexion (i.e., the range at which the convex cam surface **106** of the posterior cam **50** contacts the concave cam surface **110** of the spine **30**) of the orthopaedic prosthesis **10** may be dependent upon one or more criteria such as the size of the orthopaedic prosthesis **10**, the patient's anatomy, or the like. In the illustrative embodiment of FIGS. **22-28**, the orthopaedic prosthesis is configured to have an early flexion range of about 50 degrees to about 100 degrees and a late flexion range of about 100 degrees to about 150 degrees, but other ranges of flexion may be used in other embodiments.

It should also be appreciated that because the cam surface **100** of the posterior cam **50** includes the concave cam surface **104** and the convex cam surface **106** and the cam surface **102** of the spine **30** includes the convex cam surface **108** and the concave cam surface **110**, the contact surface area between the posterior cam **50** and the spine **30** is increased relative to orthopaedic prostheses wherein the posterior cam and/or the spine include planar cam surfaces or cam surfaces having only a concave or convex surface. In particular, because the concave cam surface **104** of the posterior cam **50** and the convex cam surface **108** of the spine **30** each have large radius of curvatures, the contact area between the posterior cam **50** an the spine **30** is increased during early flexion. Additionally, as discussed above, because the contact between the posterior cam **50** and the spine **30** is spread across a greater contact area, the anterior wear of the spine **30** may also be decreased.

While the disclosure has been illustrated and described in detail in the drawings and foregoing description, such an illustration and description is to be considered as exemplary and not restrictive in character, it being understood that only illustrative embodiments have been shown and described and that all changes and modifications that come within the spirit of the disclosure are desired to be protected.

There are a plurality of advantages of the present disclosure arising from the various features of the devices and assemblies described herein. It will be noted that alternative embodiments of the devices and assemblies of the present disclosure may not include all of the features described yet still benefit from at least some of the advantages of such features. Those of ordinary skill in the art may readily devise their own implementations of the devices and assemblies that incorporate one or more of the features of the present invention and fall within the spirit and scope of the present disclosure as defined by the appended claims.

The invention claimed is:

1. An orthopaedic prosthesis comprising:

a tibial bearing configured to be coupled to a tibial tray, the tibial bearing having a platform and a spine extending upwardly from the platform, the spine having a posterior side including a cam surface having a first section that is convexly curved in the sagittal plane and a second section that is concavely curved in the sagittal plane, and

a femoral component configured to articulate with the tibial bearing, the femoral component including (i) a pair of spaced apart condyles defining an intracondylar notch therebetween, (ii) a posterior cam positioned at a posterior end of the intracondylar notch, the posterior cam including a cam surface having an anterior section that is concavely curved in the sagittal plane and a posterior section that is convexly curved in the sagittal plane, and (iii) an anterior surface positioned at an anterior end of the intracondylar notch such that the intracondylar notch includes an opening defined between the posterior cam and the anterior surface,

wherein (i) during a first range of flexion starting at greater than or equal to 0 degrees of flexion, the posterior cam is spaced apart from the spine, (ii) during a second range of flexion starting at greater than or equal to 50 degrees of flexion, the anterior section of the cam surface of the posterior cam contacts only the first section of the cam surface of the spine and posterior section of the cam surface of the posterior cam is spaced apart from the spine, (iii) during a third range of flexion starting at greater than or equal to 80 degrees of flexion, the anterior section of the cam surface of the posterior cam contacts the first section of the cam surface of the spine and posterior section of the cam surface of the posterior cam contacts the second section of the cam surface of the spine, and (iv) during a fourth range of flexion starting at greater than or equal to 100 degrees of flexion, the anterior section of the cam surface of the posterior cam is spaced apart from the spine and the posterior section of the cam surface of the posterior cam contacts only the second section of the cam surface of the spine.

2. The orthopaedic prosthesis of claim **1**, wherein the spine of the tibial bearing and the posterior cam of the femoral component each have a substantially “S”-shaped cross-sectional profile.

3. The orthopaedic prosthesis of claim **1**, wherein the first section of the cam surface of the spine of the tibial bearing is located superiorly relative to the second section of the cam surface of the spine.

4. The orthopaedic prosthesis of claim **1**, wherein the first range of flexion is about 0 degrees of flexion to about 50 degrees of flexion.

5. The orthopaedic prosthesis of claim **1**, wherein the second range of flexion is about 50 degrees of flexion to about 80 degrees of flexion.

6. The orthopaedic prosthesis of claim **1**, wherein the third range of flexion is about 80 degrees of flexion to about 100 degrees of flexion.

7. The orthopaedic prosthesis of claim **1**, wherein the first section of the spine of the tibial bearing is defined by a first radius of curvature and the second section of the spine is defined by a second radius of curvature different from the first radius of curvature.

8. The orthopaedic prosthesis of claim **1**, wherein the anterior section the posterior cam of the femoral component is defined by a first radius of curvature and the posterior section of the posterior cam is defined by a second radius of curvature different from the first radius of curvature.

9. The orthopaedic prosthesis of claim **1**, wherein:

the anterior section of the cam surface of the posterior cam is a first anterior section, and

the cam surface of the posterior cam includes a second anterior section positioned anterior of the first anterior section, the second anterior section being convexly curved in the sagittal plane.

10. An orthopaedic prosthesis comprising:

a tibial bearing configured to be coupled to a tibial tray, the tibial bearing having a platform including a medial bearing surface and a lateral bearing surface and a spine extending upwardly from the platform between the medial bearing surface and the lateral bearing surface, the spine having a posterior side including a cam surface having a first section that is convexly curved in the sagittal plane and convexly curved in the transverse plane, and a second section that is concavely curved in the sagittal plane and convexly curved in the transverse plane, and

a femoral component configured to articulate with the tibial bearing, the femoral component including (i) a pair of spaced apart condyles defining an intracondylar notch therebetween, (ii) a posterior cam positioned at a posterior end of the intracondylar notch, the posterior cam including a cam surface having an anterior section that is concavely curved in the sagittal plane and a posterior section that is convexly curved in the sagittal plane, and (iii) an anterior surface positioned at an anterior end of the intracondylar notch such that the intracondylar notch includes an opening defined between the posterior cam and the anterior surface,

wherein (i) at a flexion angle of about 0 degrees of flexion, the posterior cam is disengaged from the spine, (ii) only the anterior section of the cam surface of the posterior cam contacts the first section of the cam surface of the spine during a first range of flexion starting at a flexion angle of at least about 50 degrees, and (iii) contact between the posterior cam and the spine transitions to contact between the posterior section of the cam surface of the posterior cam and the second section of the cam surface of the spine in a second range of flexion starting at a flexion angle of at least 80 degrees,

wherein the first section of the cam surface of the spine of the tibial bearing is located superiorly relative to the second section of the cam surface of the spine,

wherein the spine of the tibial bearing and the posterior cam of the femoral component each have a substantially "S"-shaped cross-sectional profile in the sagittal plane.

11. The orthopaedic knee joint prosthesis of claim **10**, wherein the first range of flexion is about 50 degrees of flexion to about 80 degrees of flexion and the second range of flexion is about 80 degrees of flexion to about 150 degrees of flexion.

12. The orthopaedic prosthesis of claim **10**, wherein the anterior section of the cam surface of the posterior cam is a first anterior section, and the cam surface of the posterior cam includes a second anterior section positioned anterior of the first anterior section, the second anterior section being convexly curved in the sagittal plane.

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